Attribution for Nuclear Devices Based on Reactor Grade Fuel

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There are presently 439 reactor power plants and 264 research reactors in operation, and 33 reactors under construction around the world (Fig. 1). These reactors are producing 35,000 kg of plutonium (Pu) per year. This is to be compared with the critical mass of reactor grade Pu of 8 kg, as used by the International Atomic Energy Agency. It is unclassified that the U.S. fielded a successful nuclear test of a device based on reactor grade Pu, and reactor grade Pu is known to work as a nuclear weapon fuel. In this project we have been combining nuclear physics, radiochemistry, and weapons design to develop the tools needed for attribution of a nuclear attack on the U.S. using a device based on reactor grade fuel.

The key difference between weapons grade fuel and reactor grade fuel is the ratio of the Pu isotopes that each contains. Reactor grade fuel typically contains 60% ^{239}Pu, 20% ^{240}Pu, 14% ^{241}Pu, and 5% ^{242}Pu. This is to be compared with 93% ^{239}Pu, 6.5% ^{240}Pu, and 0.5% ^{241}Pu in weapons grade Pu. The even isotopes of Pu (240 and 242) have high spontaneous fission rates, which leads to an increased probability of preinitiation. We are deriving improved models of preinitiation and examining the restrictions on feasible designs arising from the high spontaneous fission rates. In this way we can provide a distribution of probable yield distribution for a class of possible designs.

Detailed analysis of the Pu isotopics determines: (1) the type of reactor used to generate the fuel, (2) the burn time of the fuel in the reactor, and (3) the sophistication of the nuclear device. Because ^{241}Pu decays to ^{241}Am, the ^{241}Am-content of the fuel can be used to age the fuel (see Fig. 2). We are presently developing a set of tools to allow a determination of the predetonation isotopics from postdetonation radiochemical debris analysis. This will allow attribution in the event of a domestic nuclear attack from a device that uses reactor grade Pu.

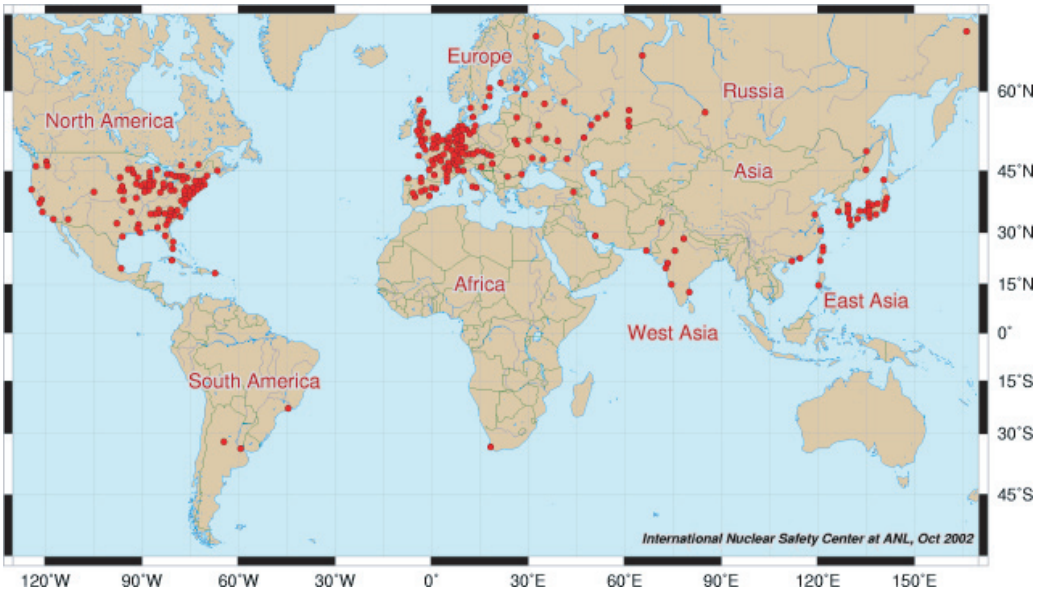

Figure 1—
Reactor locations around the world.

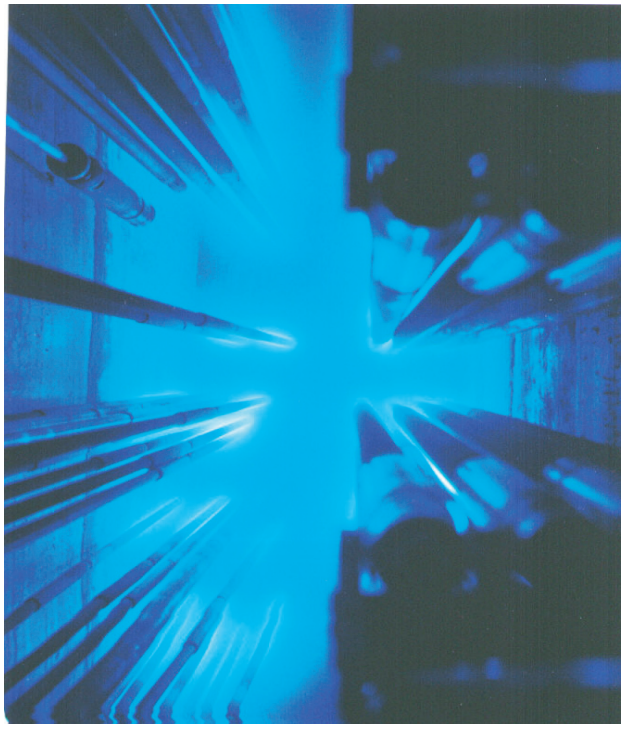

Figure 2—
As fuel rods cool ^{241}Am grows in ^{241}Am determines age of fuel.

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